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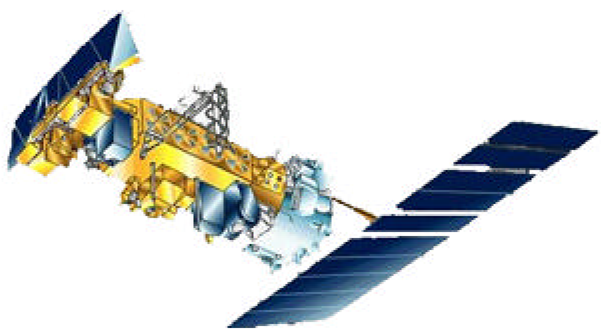
POLAR OPERATIONAL ENVIRONMENTAL
SATELLITES (POES) PROGRAM

NOAA-M

ON-ORBIT VERIFICATION AND SUPPORT PLAN



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NOAA-M

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CHANGE RECORD PAGE

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1. INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA)-M spacecraft is scheduled for launch in 2002. The National Aeronautics and Space Administration (NASA) Polar Operational Environmental Satellites (POES) Project is planning to conduct the on-orbit verification (OV) tests, as defined in the *NOAA-M On-orbit Verification Test Description and Analysis Plan*, for the NOAA-M. The OV is designed to check out each subsystem and instrument on NOAA-M. The test data will be analyzed and the results will be documented in a presentation to NOAA at the conclusion of the OV period, and subsequently in the final OV Test Report.

1.1 PURPOSE

This document presents the plan for NOAA-M OV activities and defines the detailed support required to execute these activities. It reflects the thinking of the NASA Goddard Space Flight Center (GSFC) POES Program at the time of publication. While there may be changes as planning for the OV period continues, it is anticipated that this plan will remain substantially applicable. The details of each OV test will be fully documented in the *NOAA-M On-orbit Verification Test Description and Analysis Plan* and maintained under configuration control.

1.2 BACKGROUND

The NOAA-M spacecraft is the third of the K, L, M, N, N' series of Advanced Television Infrared Observation Satellite (TIROS)-N (ATN) spacecraft. Comprehensive OV was conducted for the NOAA-K and -L, due to their significant differences in the spacecraft bus and instrument complement compared to the previous ATN satellites. The on-line tests were conducted from the NOAA Satellite Operations Control Center (SOCC) in Suitland, Maryland, and the off-line data analyses were conducted from the GSFC in Greenbelt, Maryland. Based on the large similarities for the NOAA-M. There is a new test for NOAA-M that evaluates the Digital Data Recorder (DDR). CCR 1919

1.3 SCOPE

This OV plan is a technical document describing how the NOAA-M spacecraft subsystems and instruments will be tested during the post-launch checkout period. It provides a detailed plan in supporting the OV of the NOAA-M spacecraft. The on-line tests will be conducted from the NOAA SOCC and with support as needed at the Command and Data Acquisition (CDA) stations, located in Wallops Island, Virginia, and Fairbanks, Alaska. The off-line data analyses will be conducted from the NASA GSFC in Greenbelt, Maryland. The OV tests will be performed by a team of spacecraft and instrument engineers from NASA, NOAA, their supporting contractors, operations personnel, the spacecraft manufacturer, and instrument vendors.

The major sections are briefly described below. A list of references, a list of acronyms, and the appendices appear at the end of this document.

1.3.1 Introduction

Section 1 presents an OV overview, philosophy and goals of OV testing, as well as a top-level timeline.

1.3.2 Spacecraft

Section 2 presents the verification activities for each spacecraft subsystem. The spacecraft OV test numbering system is presented in Appendix A.

1.3.3 Payload

Section 3 describes payload/instrument OV activities that include the Data Collection System (DCS) and the Search and Rescue (SAR) complement. The payload OV test numbering system is presented in Appendix A.

1.3.4 Science Data

OV is primarily an engineering test of the spacecraft subsystems and the instruments. Final calibration of the instrument science data is not part of the plan since that is a NOAA responsibility. Similarly, NASA is not responsible for the production of the various operational polar data products that originate from the NOAA-M instrument data. Nonetheless, the NASA OV plan does include an assessment of the science data from these instruments. Section 4 describes NASA's role in the NOAA-M OV activities regarding the science data evaluation.

1.3.5 OV Test Conduct

Section 5 defines the organizational roles and responsibilities of NASA GSFC and NOAA SOCC. This section also provides the staffing plan for the OV period. OV test resource requirements are included in this section.

1.4 OV OVERVIEW

The OV of the NOAA-M spacecraft and payload instruments will be conducted in two phases: the activation phase and the evaluation phase. OV tests will be performed during both phases. Handover from NASA to NOAA will occur at the end of the activation phase.

1.4.1 Activation Phase

The activation phase begins at launch and continues for approximately 21 days. The primary goal during the first 100 hours is to establish the spacecraft bus functional operability. During that period, most instruments will be either off or in a standby mode, i.e., not transmitting data. By the end of the activation phase, all instruments and other payload entities will be on.

1.4.2 Evaluation Phase

The evaluation phase starts at handover from NASA to NOAA and lasts until approximately 45 days after launch. This phase will definitively characterize the performance of all spacecraft subsystems and instruments, which will be functionally tested and assessed for compliance with performance specifications. An initial, quick-look verification of the adequacy of the instrument science data will be performed where applicable, followed by more extensive verification.

As each OV test is completed, the responsible lead engineer, together with the OV team, will collect and analyze data to complete closure of that test. The OV team will consist of representatives from NASA, NOAA, support contractor personnel, Lockheed-Martin Space Systems Company (LMSSC), and instrument vendors, as appropriate. The completed test reports will provide the data for the post-launch presentation to NOAA and will subsequently be integrated into the NOAA-M OV Test Report.

1.5 OV PHILOSOPHY, GOALS, AND REQUIREMENTS

Spacecraft/instrument operational health and safety is of primary importance throughout the OV program.

1.5.1 NOAA-M OV Philosophy

The POES test philosophy is intended to strike a reasonable compromise between thoroughness of testing and operational jeopardy due to repeated switching, length of operation, or stressful operation. Only the primary subsystems and components will be verified on the spacecraft bus and instruments. Backup components or redundant configurations will not be tested as a general rule.

Nominal operational modes will be verified for both spacecraft subsystems and instruments. However, some subsystem and instrument tests, in order to characterize their performance, may require placing them in non-nominal, although safe, operational conditions. These tests will be evaluated and approved as part of the standard review process and will be verified on an appropriate simulator, if possible.

Since real-time spacecraft contact is limited, planning for test command loading and execution, and for tape recorder operations, will be carefully coordinated with normal housekeeping activities. Those relatively few tests that require non-nominal conditions will be planned for a short duration (<10 minutes) and conducted during a real-time contact period, with data being monitored in real-time. Contingency procedures will be provided at the SOCC for emergency execution, in the event of serious anomaly, to place the spacecraft in a safe operating mode. The majority of tests will be loaded for execution at orbital locations where testing conditions are optimal and after prerequisite data analysis has verified that it is safe to proceed. Where possible, tests will be conducted in parallel.

Spacecraft subsystem testing begins at the first orbit to determine functional operability of the bus. Instrument testing begins after nominal bus performance is verified by the FOT and the instruments have adjusted to the environment. This occurs after they are thermally stabilized and completely outgassed.

Manufacturers' recommendations, as documented in the *NOAA-M On-orbit Verification Test Description and Analysis Plan*, are followed.

1.5.2 NOAA-M OV Goals and Requirements

The general goals of the NOAA-M OV are to characterize the operation of the spacecraft and instruments, verify compliance with performance specifications, and resolve all documented anomalies with the spacecraft manufacturer, instrument vendors, and the operations personnel.

1.5.2.1 Activation Phase OV Goals—The goals of the OV activation phase are:

- To verify that appendage deployments occurred properly, at the appropriate time, and were completed successfully
- To verify that orderly activation of the spacecraft subsystems and instruments has occurred
- To perform health and safety monitoring of the spacecraft and instruments
- To verify command and operational databases

1.5.2.2 Activation Phase OV Requirements—The OV requirements for the activation phase are to verify that:

- All spacecraft subsystems are activated, functioning properly in a stable manner, and are operating within specifications
- Instrument temperature environments are properly controlled and stable as they acclimate to the space environment

1.5.2.3 Evaluation Phase OV Goals—The goals of the OV evaluation phase are:

- To perform engineering characterization of subsystems, components, and instruments
- To verify command and operational databases

1.5.2.4 Evaluation Phase OV Requirements—The OV requirements for the evaluation phase are to verify that:

- Spacecraft subsystems perform to specifications
- Instruments perform to specifications/goals
- Spacecraft and instrument characteristics are established
- Command and operational databases are correct
- Spacecraft and instrument trending baselines have begun

1.6 NASA-NOAA ROLES AND RESPONSIBILITIES

This section summarizes the roles and responsibilities of NASA and NOAA related to NOAA-M OV during pre-launch, activation, and evaluation, as they are formalized in the *Memorandum of Understanding - NOAA-K, L, M, N, N¢ Joint Launch and Mission Operations* between the two agencies. No distinction is made in this document between civil service and contractor personnel; i.e., a NASA responsibility could be performed either by NASA personnel or by NASA-managed contractors.

1.6.1 NOAA-M OV Test Planning, Development, Procedures, and Team Designation

At pre-launch, the NASA GSFC POES Project performs OV planning by defining the tests that will be conducted during activation and evaluation. Teams are established for each spacecraft subsystem and instrument. They consist of the lead NASA engineer in each area, appropriate spacecraft contractor and instrument vendor personnel, and support contractors. These teams develop the test descriptions (per the Appendix B format) and the detailed information needed for each test (e.g., expected counts by orbit position), and identify all tools needed to analyze the results. The tests are reviewed, approved, and prioritized by NASA with input from NOAA, and documented in the *NOAA-M On-orbit Verification Test Description and Analysis Plan*. On-line are translated into SOCC command procedures by NOAA operations personnel. The final test schedule and instrument activation time table is incorporated by NOAA operations personnel into the Flight Time Table (FTT), based on NASA's direction.

During the activation and evaluation periods, NASA provides an OV test team that executes the OV tests based on the FTT. The OV test team consists of a test coordinator, a spacecraft OV team leader, a team for each subsystem, an instrument OV team leader, and a team for each instrument. A NASA engineer leads each team with support from the spacecraft contractor, instrument vendors, NOAA engineers, and support contractors. This team monitors NOAA-M as the tests are run, and also collects performance data. The timeline will be adjusted as needed in response to spacecraft conditions using configuration control procedures. The staffing level will vary during the post-launch period depending on the testing in progress. Close coordination is required between the NASA OV test team and NOAA operations personnel.

1.6.2 NOAA-M OV Organizational Responsibilities

Tables 1-1, 1-2, and 1-3 describe the responsibilities by task for each phase of the NOAA-M OV.

Table 1-1. Pre-Launch Phase Responsibilities

Task Description	NASA	NOAA
Develop Contingency Operations Procedures (COPs)	Lead	Support
Develop simulation plans/conduct simulations	Lead	Support
Provide Spacecraft (S/C) analog tapes for ground system verification	Lead	Support
Develop staffing plan/define the OV test team	Lead	Support
Develop the FTT for the OV tests	Lead	Support
Provide telemetry and command formats/data base information	Lead	Support
Provide Polar Acquisition and Control System (PACS) OV test team training	Support	Lead
Provide scheduling equipment and personnel for pre-launch operations	Support	Lead
Build and maintain S/C and instrument data bases	Support	Lead
Build nominal procedures	Support	Lead
Operate a ground systems incident reporting system	Support	Lead
Provide pre-launch ephemeris tapes	Support	Lead

Table 1-2. Activation Phase Responsibilities

Task Description	NASA	NOAA
Provide Mission Operations Manager (MOM)	Lead	Support
Provide activation phase on-orbit checkout team	Lead	Support
Determine S/C and instruments status	Lead	Support
Maintain S/C and instruments health and safety	Lead	Support
Execute activation phase FTT	Lead	Support
Log/document all activation phase activities	Lead	Support
Note anomalies and initiate corrective action	Lead	Support
Schedule, operate, and maintain the SOCC, CDA, and Central Environmental Satellite Computer System (CEMSCS) facilities	Support	Lead
Provide a NOAA manager(s) as primary interface to the NASA MOM	Support	Lead

Table 1-3. Evaluation Phase Responsibilities

Task Description	NASA	NOAA
Provide evaluation phase on-orbit checkout team	Lead	Support
Execute evaluation phase phase FTT	Lead	Support
Determine S/C and instruments status	Lead	Support
Provide a post-evaluation phase report/presentation	Lead	Support
Provide personnel to maintain the SOCC	Support	Lead
Schedule, operate and maintain SOCC and CDA facilities	Support	Lead
Provide CEMSCS data products	Support	Lead
Identify needed PACS and CEMSCS data base upgrades	Support	Lead
Maintain S/C and instruments health and safety	Support	Lead

1.7 NOAA-M OV BRIEFINGS

OV briefings will be conducted at the SOCC on a daily basis during the activation phase and will serve as a forum for the coordination of test activities and the dissemination of spacecraft operational information and test status. The briefing agenda will be chaired by the test coordinator and will include, but not be limited to, the following topics:

- Current spacecraft and ground system status
- NOAA-M OV schedule for the day
- Status of the previous day's activities
- Summary of all problems and anomalies encountered and resolution status
- Changes and update summary to the NOAA-M OV schedule

1.8 NOAA-M OV TIMELINE

The timeline presented in Table 1-4 lists the NOAA-M key milestones.

Table 1-4. NOAA-M OV Key Milestones

Time	Event
Launch + 34 Minutes	AGS to orbit mode handover
Launch + 100 Hours	LMSSC engineers depart from the SOCC
Launch + 21 Days	Activation phase completed
Launch + 45 Days	Evaluation phase completed
Launch + 3 Months	OV briefing to NOAA
Launch + 5 Months	OV report published

2. SPACECRAFT

2.1 GENERAL APPROACH

This section presents the spacecraft OV tests that NASA performs during the first 45 days after launch. Testing that NOAA performs is not within the scope of this document.

Subsystem trending data are collected routinely throughout the life of the spacecraft. Trending data collection is not part of specific OV tests, but it is a task that must be performed during the OV period.

2.2 SYSTEM CONSIDERATIONS

The system performance will be evaluated on how well NOAA-M supports the instrument requirements; maintains earth pointing; provides sufficient electrical power for all sun angles; collects, stores and transmits instrument and spacecraft data; receives commands and executes valid stored and real-time commands; collects, stores and transmits telemetry data over communication links; and maintains spacecraft components within specified temperature limits at all times.

This evaluation will analyze and characterize the interaction of the individual subsystems and instruments with each other and determine how well the overall spacecraft system requirements are being achieved. All subsystems are interdependent to some extent. For example, the attitude control is dependent upon the structural stiffness of the Solar Array (SA), thermal control is dependent upon power and attitude control, and the orbit altitude is dependent upon the performance of the Reaction Control Equipment (RCE).

Because of the inherent risks involved, verification is limited for redundancy, safe modes, and extensive cross strapping.

2.2.1 System-level On-orbit Tests

There are several tests that can be performed to evaluate the spacecraft's performance on the system level. These tests can be conducted as stand-alone tests having a dedicated block of time, or as integrated tests that are conducted in parallel with other tests. In some cases the latter approach may prove to be more useful or more efficient. Table 2-1 summarizes the system-level tests.

Table 2-1. System-level On-orbit Tests

OV Test Number	Name
SYS001	On-orbit Electromagnetic Interference (EMI) Test
SYS002	On-orbit Self-compatibility Test
SYS003	Day/Night Transition Effects on Spacecraft Subsystems and Instruments
SYS004	Instrument Microphonic Coupling

SYS005	Ascent Guidance Software (AGS)

OV tests SYS001 through SYS004 are conducted in real-time, with in-depth data analysis being performed off-line. For OV Test SYS005, extensive data collection and off-line data analysis are required.

2.2.2 Changes from NOAA-L

The following tests that were planned for the NOAA-L OV will not be repeated:

- Instrument Mounting Misalignment
- On-orbit Solar Array Drive (SAD) Positioning Software Test

NOAA-16 instrument misalignments were detected by other means and verified by other OV tests. The software test was a one-time on-orbit test of a new flight software module.

2.3 SPACECRAFT SUBSYSTEMS

This section defines the OV tests that will evaluate and characterize the performance of the spacecraft subsystems. These tests are designed to evaluate how well each subsystem fulfills its requirements and to provide a detailed assessment of the subsystem performance on orbit.

2.3.1 Attitude Determination and Control

2.3.1.1 Subsystem Description— The Attitude Determination and Control Subsystem (ADACS) performs two major functions-boost phase orbit insertion guidance, and mission phase acquisition and control of spacecraft attitude. The ADACS provides closed loop acquisition of the local vertical and orbit normal after handoff from the AGS. It also provides reacquisition of the local vertical and orbit normal if required. The ADACS maintains three-axis control of the spacecraft within attitude and rate requirements, and will provide earth sensor, sun sensor, and gyro telemetry for the three-axis attitude determination on the ground. The ADACS provides momentum unloading, using magnetic coils, nitrogen thrusters, or both. The ADACS consists of four reaction wheels, redundant roll/yaw coils, redundant pitch coils, one earth sensor (with redundant electronics), one sun sensor and an Inertial Measurement Unit (IMU) with redundant channels for each axis.

There are seven modes of operation of ADACS for controlling the attitude and rates of the spacecraft. These modes are rate nulling, search, yaw gyrocompassing, nominal, coast, spindamp, and despin and are described in the following paragraphs.

The rate nulling mode is used to rate stabilize the roll, pitch, and yaw axes after handover from the AGS. The rates are sensed by the gyros with a damping torque supplied by the reaction wheels. Rate nulling is complete when all three axes' body rates are simultaneously below 0.014 deg./sec. for 10 seconds.

The search mode is used to acquire the earth if it is not present in all four quadrants of the earth sensor. Fixed roll and/or pitch torque rates are developed according to the status of the four earth sensor quadrants. This mode continues until the proper pitch and roll attitude is obtained. The yaw axis rate is nulled during this maneuver.

The yaw gyrocompass mode uses a combination of the gyro-sensed rotation rates about the roll and yaw axes as a control reference for the yaw axis. Using this signal, the +Z axis is aligned with the orbit normal.

The nominal mode is the normal operating mode. With the yaw attitude converged and earth lock achieved, the ADACS maintains the spacecraft control axes to within +/-0.2 deg. per axis (3 σ) of the local geodetic reference. The Earth Sensor Assembly (ESA) supplies the pitch and roll reference and the gyros and sun sensor provide the yaw reference. The gyros provide the three axis rate signals for rate damping.

The coast mode is automatically entered if there is an ESA outage during the nominal mode. The pitch and roll axes are controlled by rate nulling and the yaw axis controlled by the nominal mode yaw attitude control law.

In the spindamp mode the reaction wheels are used to align the spacecraft Y-axis along the spacecraft momentum vector and to damp nutations. This mode is only used during emergency operations and is commanded by the ground.

The despin mode uses the roll/yaw coil to produce a despin torque along the Y-axis and reduces the spacecraft angular momentum. The ground commands this mode.

2.3.1.2 On-orbit Verification—The on-orbit performance of the ADACS is evaluated by observing how well the requirements of the ADACS are achieved during the on-orbit portion of the flight. The AGS boost phase performance is also evaluated in this manner. The pointing performance is partially evaluated by monitoring the sensor outputs to verify that they are within the required limits for accuracy and rates. A comprehensive test to measure pointing accuracy is planned using Advanced Very High Resolution Radiometer (AVHRR) imagery.

2.3.1.3 On-orbit Tests—The on-orbit tests listed in Table 2-2 will be used to evaluate and characterize the performance of the ADACS. The tests are designed to characterize ADACS performance for all operations. Tests are also included that will evaluate and characterize specific ADACS hardware, especially the IMU and the reaction wheels. Many of these tests will be evaluated in real-time but the in-depth analysis will be performed off-line using data that has been previously obtained. Transitions between modes will also be evaluated as part of the characterization of the ADACS.

All the on-orbit tests performed for NOAA-L will be performed again for NOAA-M, without significant changes.

Table 2-2. ADACS Performance Tests

OV Test Number	Name
ADC001	ADACS Status and Configuration Checklist
ADC002	Rate Nulling Mode
ADC003	Search Mode
ADC004	Attitude Control – Yaw Gyrocompass Mode
ADC005	Attitude Control – Nominal Mode
ADC006	Attitude Determination
ADC007	Attitude Control in Nominal Mode (Instrument Activation)
ADC008	Momentum Management and Torquer Coil Performance
ADC009	ESA Performance
ADC010	SSA Performance
ADC011	RWA Performance
ADC012	IMU Performance
ADC013	Disturbance Torques
ADC014	Sun Sensor Yaw Updates

2.3.1.4 Trending Data—The following items, as a minimum, should be tracked for long-term changes or trends:

- ESA Channel A & B analog outputs
- Gyro motor currents
- Gyro drift
- Gyro block temperature
- RWA motor currents

2.3.2 Communications

2.3.2.1 Subsystem Description—The Communications Subsystem (CS) receives and demodulates ground commands to the spacecraft and transmits spacecraft data to ground stations. The CS consists of three data transmitters in the meteorological S-band (STX1, STX2, and STX3), one launch telemetry transmitter in the Air Force Satellite Control Network (AFSCN) band (STX4), two VHF real-time APT Transmitters (VTXs), two VHF Beacon Transmitters (BTXs), four S-band Omni-telemetry Antennas (SOAs), two S-band omni-command antennas, a beacon antenna, a UHF DCS/SAR Processor (SARP) receiver Antenna (UDA), a diplexer for coupling received signals to both the DCS and SARP, a SAR Receiver (SARR) Receiver Antenna (SRA), and a SARR L-band transmitter Antenna (SLA).

2.3.2.2 On-orbit Verification—The CS is evaluated by how well the requirements of the subsystem are achieved during on-orbit operation. The transmitted downlink powers (EIRPs) and their frequencies will be evaluated. The Ground Spacecraft Tracking and Data Network Receiver Demodulator (GRD) receiver acquisition threshold will be measured and compared to the requirements. The Radio Frequency (RF) link calculations and margins including bit error rate, modulation parameters and spectral occupancy will be verified. In addition, the receiving antenna pattern characterization is planned using the CDA RF ground facilities.

2.3.2.3 On-orbit Tests—The on-orbit tests listed in Table 2-3 are used to evaluate and characterize the performance of the CS. The tests are designed to collect data to characterize the performance for all operations of the CS. Some parameters will be evaluated in real-time, but in-depth analysis will be performed off-line using the collected data. The results of these tests will, where appropriate, be compared with System Electrical Performance Evaluation Test (SEPET) data as part of the subsystem evaluation.

Table 2-3. CS Performance Tests

OV Test Number	Name
COM001	Communications Subsystem Status and Configuration Checklist
COM002	Satellite Effective Isotropic Radiated Power (EIRP) and Antenna Pattern Characterization
COM003	Downlink Signal Frequencies and Spectral Occupancy
COM004	GRD Receiver Command Threshold
COM005	Modulation Index
COM006	Bit Error Rate (BER)

2.3.2.4 Changes from NOAA-L—OV Test COM004 is the combination of two NOAA-L tests. The previous tests were:

- GRD Receiver Acquisition and Tracking
- GRD Receiver Command Threshold

2.3.2.5 Trending Data—The following items, as a minimum, should be tracked for long-term changes or trends:

- STX RF power outputs
- VTX RF power outputs
- Transmitter temperatures
- EIRP

2.3.3 Command and Control

2.3.3.1 Subsystem Description—The Command and Control Subsystem (C&CS) provides ascent guidance from booster separation through orbit injection and controls the spacecraft attitude and operating modes in orbit. This control is exercised by using commands and data from the ground, and signal data from the onboard subsystem. The C&CS consists of Redundant Crystal Oscillator (RXO), Controls Interface Unit (CIU), Standard Controls Processor 1 (CPU 1), Standard Controls Processor 2 (CPU 2), Signal Conditioning Unit (SCU), Controls Power Converter (CPC), CIU Annex (CXU), and Decryption Authentication Unit (DAU).

2.3.3.2 On-orbit Verification—The on-orbit performance of the C&CS can be evaluated by observing the performance of the RXO, CIU, CPU 1, CPU 2, SCU, CPC, CXU, and DAU. The performance of these units provides an end-to-end indication of the performance of the subsystem. Telemetry provides data on the state of the C&CS units as well as temperatures and voltages. These parameters should be monitored during the pre-launch, boost, and on-orbit phases of the mission. The performance of the C&CS is compared with the performance during the SEPET testing.

Much of the C&CS OV will occur as a by-product of normally planned early orbit operations. Verification of the performance of the input and output busses (CPUs, CIU, CXU, etc.), bus interface control buffers, non-standard interfaces, interrupt system, and timing is done through observation of the performance of the controlled hardware.

Nominal subsystem control is baselined at the initiation of orbit mode. Should the spacecraft enter safe states because of anomalies, then the performance of the redundant hardware would be verified at that time.

The C&CS on-orbit checkout starts with processing commands in plain text mode. Both CIU-decoded and CPU-decoded commands will be sent as part of the normal CDA pass. The command processing system will be verified as part of the normal command flow. No extraordinary commanding is necessary to verify the integrity of the primary command path and components.

Flight software algorithms, whose function supports the performance of other subsystems, will be verified as part of the on-orbit performance verification of the respective subsystem.

The CPU reset and default settings will have been accomplished prior to launch. The switch from boost to orbit mode should have occurred automatically. Other resets or default load overrides should not be required in nominal operations. As part of nominal operations, certain resets may be sent to other subsystems and the capability verified during nominal operations. Also as part of nominal operations, the capability to load ephemeris updates and command loads, etc., will be verified.

The ability of the CPU and spacecraft to provide CPU dumps will be verified as part of the normal, routine activation phase CPU dump to verify memory content.

The performance of Flight Software algorithms, in support of other subsystems, will be verified as part of the respective subsystem OV.

2.3.3.3 On-orbit Test—There will be a single test to evaluate the C&CS. It is OV Test CCS001, CCS Status and Configuration Checklist.

2.3.3.4 Changes from NOAA-L— The following tests that were performed during NOAA-L OV will not be repeated:

- Encrypted Commanding
- Clock Update Test

The encryption test is unnecessary because encryption is the normal mode of operation. The clock update test was a one-time on-orbit test of a flight software modification.

2.3.3.5 Trending Data—The following items, as a minimum, should be tracked for long-term changes or trends:

- RXO oven temperatures
- CIU converter outputs

2.3.4 Data Handling Subsystem

2.3.4.1 Subsystem Description—The Data Handling Subsystem (DHS) processes and formats all housekeeping telemetry data and all payload data with the exception of the SARR. The DHS has the following components: TIROS Information Processor (TIP), Advanced Microwave Sounding Unit (AMSU) Information Processor (AIP), Manipulated Information Rate Processor (MIRP), four Digital Tape Recorders (DTRs), one DDR and the Cross-Strap Unit (XSU). CCR 1919

2.3.4.2 On-orbit Verification—The on-orbit performance of the DHS can be evaluated by observing the performance of the TIP, AIP, MIRP, DTRs, DDR and XSU. The TIP performance can be evaluated by observing the format of the downlink data; the AIP performance, by observing the processing and formatting of AMSU data; the MIRP performance, by observing the processing and formatting of the AVHRR data. Telemetry provides data on the state of the DHS as well as temperatures and voltages. These parameters should be monitored during the pre-launch, boost, and on-orbit phases of the mission. The on-orbit performance of the DHS should be compared with the performance during the SEPET testing.

Much of the DHS OV will occur as a by-product of other normally planned early-orbit operations. The following paragraphs discuss how some of the DHS functions are verified in this manner.

Post-launch analysis of the ground-recorded real-time and playback telemetry verify TIP boost mode performance.

TIP orbit mode data acquisition by the CDA stations and by SOCC verifies TIP orbit mode operation.

TIP single-point dwell mode need not be separately verified but is used to characterize various electromechanical, power, and other analog parameters of other subsystems. If and when this capability is used, the dwell mode will be verified.

All spacecraft operating modes that can use the High-Resolution Picture Transmission/Local Area Coverage (HRPT/LAC) output of the MIRP are verified in concert with operations of the AVHRR, MIRP, XSU, DDR and the DTRs. Using AVHRR data, and/or MIRP substitution mode data, verify nominal performance of all downlink and recording modes.

The MIRP HRPT/LAC output during data substitution mode need not be verified.
The MIRP is placed into the MIRP test mode and all DTR tape units are characterized for performance as a function of tape position. This data is compared with the pre-launch data for trend analysis. After this test, tape unit characterization will continue trend analysis using the auxiliary sync pattern of normal AVHRR/MIRP output for BER checking.

All spacecraft operating modes that can use the Global Area Coverage (GAC) output of the MIRP shall be vigorously verified in concert with operations of the AVHRR, MIRP, XSU, DDR and the DTRs. CCR 1919
Using AVHRR data, and/or MIRP substitution mode data, verify nominal performance of all downlink and recording modes.

Nominal operations and ground image processing will verify MIRP, APT format, MIRP sample times, and MIRP format phasing.

2.3.4.3 On-orbit Tests—Some functions of the DHS will be verified by the performance of dedicated tests designed specifically for the evaluation of a particular function. These tests are described in Table 2-4.

Table 2-4. DHS Performance Tests

OV Test Number	**Name**
DHS001	DHS Status and Configuration Checklist
DHS002	MIRP Operation with AVHRR
DHS003	DDR Evaluation

OV Test DHS003 is new for NOAA-M.

2.3.4.4 Trending Data—The following items, as a minimum, should be tracked for long-term changes or trends:

- DTR pressures
- DTR playback voltages
- DTR servo errors
- XSU PLL error voltages
- MIRP converter voltages
- DDR current
- DDR temperature

2.3.5 Electrical Power

2.3.5.1 Subsystem Description—The Electrical Power Subsystem (EPS) is based on the principle of direct energy transfer from the SA. It implements a centralized regulation concept utilizing partial shunts on an electrically segmented SA during orbit day, and a multi-phase boost regulator during orbit night. It consists of a single-wing, sun-oriented SA to convert solar radiation into electrical energy. Some of the array power is stored in the batteries, via the Battery Charge Assembly (BCA), which supply power through the boost voltage regulator (BVR) to the loads during orbital eclipse and during the periods when the load power demand exceeds the SA capability.
The EPS output is maintained at +28 Vdc with a regulation of +0.56/-0.30 Vdc on the main bus and ±0.56 Vdc on the pulse bus. The EPS also provides ±10 Vdc from a low power converter with a regulation of +0.50/-0.45 Vdc. The major components are the SAs; SA telemetry commutator unit; batteries; battery reconditioning units; power control electronics, which include the Power Supply Electronics (PSE); BCA; partial shunt assembly; and CPC.

2.3.5.2 On-orbit Verification—OV will be completed in three phases. During the first phase, many of the basic functions, such as SA deployment, battery operation, etc., will be verified and various parameters will be monitored through telemetry.

The second phase is performed after a few orbits of initial operation have provided enough data to evaluate basic battery recharging and most of the PSE mode control functions. This is all done via review of normal telemetry and requires no ground intervention or commanding.

The third phase is the recording and evaluation of long-term trend data.

2.3.5.3 On-orbit Tests—The OV tests listed in Table 2-5 shall be performed.

Table 2-5. EPS Performance Tests

OV Test Number	Name
EPS001	EPS Status and Configuration Checklist
EPS002	SA Performance
EPS003	Quick Look - EPS Health and Safety with Spacecraft under Load Condition of All Instruments On
EPS004	Battery Maintenance
EPS005	PMS Performance

All the on-orbit tests performed for NOAA-L will be performed again for NOAA-M, without significant changes.

2.3.5.4 Trending Data—The following items, as a minimum, should be tracked for long-term changes and trends:

- Main bus voltage
- SA patch output
- Battery 1/2/3 high range voltages (end-of-charge, end-of-discharge)
- Battery 1/2/3 end-of-charge and end-of-discharge temperature
- Battery recharge ratio and net charge
- Battery V/T level
- Battery depth-of-discharge
- Battery orbital data plots
- Load current
- Average battery voltage – Packs 1A, 1B, 2A, 2B, 3A, 3B
- Sharing of batteries during discharge
- SA temperature
- PSE/BVR temperature
- Shunts temperature
- PSE temperature
- BCA temperature
- Battery temperature - Packs 1A, 1B, 2A, 2B, 3A, 3B

2.3.6 Reaction Control

2.3.6.1 Subsystem Description—The Reaction Control Subsystem consists of RCE which provides spacecraft separation from the booster; pitch, yaw, and roll control torque during the Apogee Kick Motor (AKM) burn; orbital velocity correction; attitude control torque during coast periods; final orbit trim; and on-orbit reaction wheel momentum unloading. The major components of the RCE are: four hydrazine rocket engines, eight nitrogen thrusters, two hydrazine propellant tanks, two nitrogen tanks, pressure regulator, pyro-valve assemblies, pressure transducers, fill and drain valves, pressure relief valve, latch valve, and manifold assemblies.

2.3.6.2 On-orbit Verification—The performance of the RCE during the ascent guidance phase will be assessed by review and analysis of the AGS data. This analysis provides AKM thrust, AKM swirl torque, hydrazine engine thrust, nitrogen engine torques, tank pressures, pressure regulator behavior, and hydrazine and nitrogen usage. The AGS control is autonomous and automatically compensates for non-catastrophic, below-normal performance of the RCE, therefore the evaluation will be done off-line after the completion of the ascent guidance phase.

The on-orbit evaluation will be concerned with the performance of the nitrogen engine assemblies if they are used for momentum unloading. The amount of remaining nitrogen will be calculated based on the tank pressures and the AGS performance. The temperatures and pressures of the RCE will be evaluated to determine if any leaks are present and long-term trend data will be recorded to evaluate temperature and tank pressure changes. Tank and line heater operation will be monitored from telemetry data to avoid the possibility of hydrazine freezing.

2.3.6.3 On-orbit Tests—Table 2-6 shows the tests that will be used to assess the RCE performance. OV Test RCE002 is a *contingency* test due to the NOAA-L testing experience.

Table 2-6. RCE Performance Tests

OV Test Number	Name
RCE001	RCE Status and Configuration Checklist
RCE002	RCE Nitrogen Engine Assemblies-*Contingency*

2.3.6.4 Trending Data—The following parameters should be monitored for long-term changes and trends:

- Tank pressures
- RCE temperatures
- Line heater operation
- Regulator pressure
- Nitrogen engine assembly performance

2.3.7 Thermal Control

2.3.7.1 Subsystem Description—The NOAA-M Thermal Control Subsystem (TCS) purpose is to maintain the spacecraft and instrument temperatures within their allowable limits during the NOAA-M mission and to control the temperature excursions within these limits.

The TCS uses passive and active temperature control methods. The passive control elements are surface finishes, blankets, shields, sunshades, conductors and isolators. The active control elements are electronic temperature controllers, thermostats, louvers, heater circuits, and launch platform air conditioning.

2.3.7.2 On-orbit Verification—The performance monitoring of the TCS during the activation phase will be concerned with the thermal effects of the AKM and hydrazine engines on the spacecraft temperature. The configuration of the TCS and spacecraft temperatures will be assessed at handover.

The TCS will be evaluated in its performance of:

- Maintaining all spacecraft temperatures within allowable limits
- Minimizing temperature differences and rates of change in temperatures
- Maintaining acceptable temperatures at instrument interfaces
- Preventing freezing of hydrazine and RCE equipment
- Limiting minimum temperatures on nitrogen components and battery reconditioning hardware

Long-term trending will be required for selected temperatures and yellow and red limits will be assigned to all telemetered temperatures.

2.3.7.3 On-orbit Tests—Table 2-7 shows the tests that will be used to assess TCS performance.

Table 2-7. TCS Performance Tests

OV Test Number	Name
THR001	TCS Status and Configuration Checklist
THR002	Propulsion Subsystem Soakback Effects
THR003	TCS Performance
THR004	Thermal Gradients and Temperature Rates of Change for Instruments

2.3.7.4 Changes from NOAA-L—OV Test THR003 encompasses the objectives of two NOAA-L OV tests that will not be repeated. The NOAA-L OV tests were:

- Hydrazine and RCE Temperature
- TCS Response to Thermal Load Changes

2.3.7.5 Trending Data—The following parameters should be monitored for long-term changes and trends:

- Selected temperatures
- Duty cycles of heaters

2.3.8 Deployment Mechanisms and Electromechanical Devices

2.3.8.1 Deployment Mechanisms and Electromechanical Devices Description—The deployment mechanisms and electromechanical devices include the SAD and its electronics, as well as the deployment mechanisms for the SA, VRA, UDA, SRA, and sunshade.

2.3.8.2 On-orbit Verification—The OV of the deployment mechanisms and electromechanical devices will be performed during the activation and evaluation phases of the mission. Long-term trending will be required for SA temperatures and the mechanism telemetry should be monitored to verify there are no changes once the SA and antennas are deployed.

The performance monitoring of the deployment mechanisms and electromechanical devices during the activation phase will be concerned with the successful deployment of the SA, Instrument Mounting Platform (IMP) sunshade, and the VRA, UDA, and SRA antennas.

During the evaluation phase of the mission the alignment between the sensors and instruments will be evaluated to determine shifts caused by the launch environment and thermal distortions. The structural stiffness will be evaluated during the ADACS on-orbit testing.

2.3.8.3 On-orbit Tests—Table 2-8 shows the tests that will be used to assess the performance of the deployment mechanisms and electromechanical devices.

Table 2-8. Deployment Mechanisms and Electromechanical Performance Tests

OV Test Number	Name
DEP001	Deployment Mechanisms and Electromechanical Devices Status and Configuration Checklist
DEP002	UDA Antenna Deployment
DEP003	SRA Antenna Deployment
DEP004	VRA Antenna Deployment
DEP005	IMP Sunshade Deployment
DEP006	SA Deployment

2.3.8.4 Changes from NOAA-L— The SAD Performance Test that was part of the NOAA-L OV will not be repeated. The SAD is not deployed. It is enabled electrically.

2.3.8.5 Trending Data—There are no parameters monitored for long-term changes and trends.

2.3.9 Flight Software

2.2.9.1 Subsystem Description—The Flight Software Subsystem (FSS) includes all on-board software modules required for on-orbit operation of the spacecraft. Also included are all data structures (variables, parameters, and constants) associated with the operation of these software modules. The FSS forms a part of the C&CS, ADACS, EPS and AGS. As such, the FSS performs many tasks associated with these subsystems. It also performs tasks concerned only with the operations of the software and the cycling of the CPU.

The major functions performed by the FSS are as follows:

- Ascent navigation and guidance
- Attitude determination: attitude sensor processing (gyros, earth sensor, sun sensors) and attitude computations
- Attitude control: control logic, control law implementation, and effector commanding (reaction wheels, magnetic torque coils, thrusters)
- Orbit propagation for magnetic unloading, sun-moon warnings, sun sensor updates, etc.
- Commanding (real-time, internal, stored, macro)
- Redundancy management (attitude sensors and effectors, OBC, S/C bus, SAD, battery charge regulator)
- Power system monitoring and regulation
- Safe state implementation
- Self-checkout
- Provide CPU telemetry

2.3.9.2 On-orbit Verification—Verification of the FSS shall be performed as an integrated portion with other subsystem tests. Where appropriate, the on-orbit results will be compared with pre-launch ground simulation data.

2.3.9.3 On-orbit Tests—Other than the verification of the AGS (OV Test SYS005, described in Section 2.2), all FSS verification is conducted as an integral part of the ADACS, C&CS, and EPS tests.

2.3.9.4 Trending Data—There are no parameters monitored for long-term changes and trends.

3. PAYLOAD

This section describes the OV activities for the payload that includes the instruments, the DCS, and the SAR complement. The DCS and SAR have established comprehensive OV processes by the instrument vendors. These will be incorporated into the overall plan, schedule, and reporting processes without any substantial modification.

3.1 GENERAL APPROACH

Instrument performance (Section 3) and science verification (Section 4) are two distinct, but mutually supportive, phases of instrument operational evaluations. As the instruments must be operating within the specification values before valid science data can be obtained, the engineering evaluations will precede the science verification phase for each instrument.

The general approach to instrument engineering evaluation is:

- Monitor and trend key telemetry parameters as indicators of health/safety, stability and reliability
- Verify functional performance
- Measure/characterize performance
- Verify specification compliance.

Some instruments, such as the Solar Backscatter Ultraviolet Spectral Radiometer (SBUV), have constraints and restrictions that establish timeline limitations for partial or full activation. The functional and specification compliance tests for these instruments will be run concurrently rather than consecutively.

For instruments with a single mode of operation (off to full on) or without activation constraints, the functional tests will be run first followed by the compliance evaluations. Applicable instruments are the AMSU-A1, AMSU-A2, AMSU-B, DCS and SAR complement.

As the instruments start producing science data streams, the data will be examined on a preliminary basis for reasonableness and range of values against anticipated (baseline) values. Anomalous behavior will be analyzed.

Science evaluations require data reduction and analysis of the Digital A science data stream by the application of processing algorithms and instrument calibration curves. A "quick-look" evaluation of the processed instrument data will be performed one week after instrument activation. As additional science evaluation results become available, they will be incorporated into the total instrument performance evaluation. This step is necessary to assure data stream fidelity and provide confirmation of the engineering evaluations. As the instruments operate over a range of temperatures and other environmental conditions, science analysis also requires a knowledge of analog telemetry engineering parameters, as well as Digital A telemetry to properly apply calibration factors for data analysis.

An essential precursor to instrument verification is the preparation of an early trend database of key telemetry data to establish a metric for performance and a standard for comparison. For the NOAA-M instruments, since they are common to previous NOAA missions, the present on-orbit values constitute the primary benchmark.

Reference values for functional and operational performance comparison are obtained from the individual instrument's documentation consisting of design specifications, interface specifications, acceptance test reports (including waivers and deviations if applicable), calibration curves for data reduction and science analysis, and the nominal (expected) value of telemetry parameters obtained during ground thermal vacuum testing. The catalog of previously obtained specification performance parameters from the instrument's individual and spacecraft level thermal vacuum tests constitutes a reference baseline.

3.2 INSTRUMENTS

3.2.1 AMSU

The AMSU is a 20-channel microwave radiometer consisting of three separate units: AMSU-A1 (Channels 3 to 15), AMSU-A2 (Channels 1 and 2), and AMSU-B (Channels 16 to 20). The AMSU and the High Resolution Infrared Radiation Sounder (HIRS)/3 jointly constitute the TIROS operational sounder package. The primary purpose of AMSU is to obtain global temperature and humidity profile data.

AMSU Channels 3 through 14 sample the 50 to 57.6 GHz oxygen band to provide data for a vertical temperature profile of the atmosphere up to 42 km. The "window" channels (1, 2, 15 and 16) provide data that will enhance the temperature sounding by correcting for surface emissivity, atmospheric liquid water, and total precipitable water. Channels 18 through 20 use the 183.3 GHz water absorption line to provide data for the humidity profile.

3.2.1.1 AMSU-A1 and -A2 On-orbit Tests—The AMSU-A1 instrument has two 6-inch diameter antennas, each having a 3.3 degree nominal field of view at the half power points. Each antenna provides a crosstrack scan of ±48.33 degrees about nadir with a total of 30 earth fields per eight-second scan period. It produces radiometric data at a rate of 2.08 kbps in the form of thirteen 16-bit words per AIP minor frame. On-orbit calibration is via internal warm load blackbody target and cold space view.

The AMSU-A2 has an 11-inch diameter antenna, which has a 3.3 degree nominal field of view at the half power points. The antenna provides a crosstrack scan of ± 48.33 degrees about nadir with a total of 30 earth fields per eight-second scan period. It produces radiometric data at a rate of 2.72 kbps in the form of seven 16-bit words per AIP minor frame. On-orbit calibration is via internal warm load blackbody target and cold space view.

Table 3-1 shows the AMSU-A1 and -A2 on-orbit evaluations that will be performed.

Table 3-1. AMSU-A1 and AMSU-A2 Performance Tests

OV Test Numbers	Name
AM1001, AM2001	Power Off/Monitor Analog Telemetry
AM1002, AM2002	Power On/Monitor Telemetry
AM1003, AM2003	Analog to Digital (A/D) Converter Evaluation
AM1004, AM2004	Space/Warm View Interference Test
AM1005, AM2005	Instrument Trending
AM1006, AM2006	Scanner Accuracy and Stability
AM1007, AM2007	Determination of Optimal Space View Calibration Position
AM1008, AM2008	Noise Measurement – All Channels
AM1009, AM2009	Satellite-To-Satellite Comparison
AM1010,AM2010	Blackbody Platinum-Resistance Thermometer Temperature Accuracy
AM1011, AM2011	Earth Scene Bias Characterization
AM1012, AM2012	Channel Registration

CCR 1919

3.2.1.2 AMSU-A Trending Data—The following parameters should be monitored for long-term changes and trends:

- Cold Counts vs. Time (Noise monitor)
- Warm Counts vs. Time (Calibration stability)
- Calibration Coefficients vs. Time
- Noise Equivalent Spectral Temperature (NEdT) vs. Time (Radiometric sensitivity stability)

3.2.1.3 AMSU-B On-orbit Tests—The AMSU-B instrument has a 12-inch diameter antenna that has a 1.1 degree nominal field of view. The antenna provides a cross-track scan of ± 49.50 degrees about nadir with a total of 90 earth fields per 2.67 seconds scan period. It produces radiometric data at a rate of 16.64 kbps, in the form of twenty-five 16-bit words per AIP minor frame. On-orbit calibration is via internal warm load blackbody target and cold space view.

Table 3-2 shows the AMSU-B on-orbit evaluations that will be performed. OV Test AMB015 is a *contingency* test due to the NOAA-L testing experience.

Table 3-2. AMSU-B Performance Tests

OV Test Number	Name
AMB001	Power Off/Monitor Analog Telemetry
AMB002	Power On/Monitor Telemetry and Partial Bias Characterization
AMB003	Noise Measurement - All Channels
AMB004	Radiometric Sensitivity - All Channels
AMB005	Scan Normal/Radiometric Calibration - All Channels
AMB006	Instrument Stability Measurement
AMB007	Science Data Soundness
AMB008	Instrument Trending
AMB009	Investigation Mode/Space View Evaluation
AMB010	A/D Converter Evaluation
AMB011	AMSU 89 GHz Window Channels Cross Comparison
AMB012	Channel Registration
AMB013	AMSU Detection of Land-Sea Boundary
AMB014	Scanner Accuracy and Stability
AMB015	Earth-View Bias Characterization-*Contingency*
AMB016	Satellite-To-Satellite Comparison

CCR 1919

3.2.1.4 AMSU-B Trending Data—The following parameters should be monitored for long-term changes and trends:

- Cold Counts vs. Time (Noise monitor)
- Warm Counts vs. Time (Calibration stability)
- Calibration Coefficients vs. Time
- Local Oscillator (LO) Temperature vs. Time (LO stability)
- NEdT vs. Time (Radiometric sensitivity stability)
- Scanner encoder positions

3.2.2 AVHRR

The AVHRR/3 is a six channel cross track scanning imaging radiometer operating in the visible, near infrared (IR), mid IR and far IR wavelength regions. It produces a scan of ± 62.5 degrees about nadir (2700-km swath) with a resolution of 1.3 milliradians squared or 1.1 km at nadir. The scientific purpose is to examine land surface imagery, cloud imagery, sea surface temperature, ice cover, snow cover extent, vegetation index, land/water boundary, volcanic ash and aerosol concentrations. As it provides six earth scans per second, video data is produced at a rate of 621.3 kbps.

At manufacture, the AVHRR/3 is calibrated absolutely with radiance standards that are National Institute of Standards and Technology (NIST) traceable. Channels 1, 2 and 3A characterize radiance by Signal to Noise (S/N) ratio whereas Channels 3B, 4 and 5 measure scene brightness temperature in their respective pass bands. On orbit, the calibration linearity and stability for Channels 3B, 4 and 5 are ascertained by cold blackbody (space) and hot built-in blackbody (approximately 300K) measurements. Channels 1, 2 and 3A are only zero radiance checked via cold space look as there is no standard radiance source (calibration lamp) available for these channels.

3.2.2.1 On-orbit Tests—Table 3-3 shows the AVHRR on-orbit evaluations that will be performed.

Table 3-3. AVHRR Performance Tests

OV Test Number	Name
AVH001	Monitor Analog Telemetry
AVH002	Cooler Outgassing
AVH003	Channels 1, 2 and 3A Turn-on
AVH004	Electronic Calibration
AVH005	Space Clamp Noise and Stability
AVH006	Imagery Evaluation - Channels 1, 2 and 3A
AVH007	S/N - Channels 1, 2 and 3A
AVH008	Earth Shield Deploy/Cooler Heater Off/Detectors Cool Down
AVH009	Channels 3B, 4 and 5 Turn-on
AVH010	NEdT/Dynamic Range - Channels 3B, 4 and 5
AVH011	Instrument Stability - Channels 3B, 4 and 5
AVH012	Imagery Evaluation - Channels 3B, 4 and 5
AVH013	Scan Linearity, Synchronization, Delta and Jitter
AVH014	Operational Calibration - Channels 3B, 4 and 5
AVH015	Instrument Trending
AVH016	GAC to LAC/HRPT Compatibility
AVH017	A/D Converter Evaluation
AVH018	AVHRR Detection of Land-Sea Boundary
AVH019	NOAA-M and NOAA-16 or -15 Comparison
AVH020	Autonomous AVHRR Channel Switch
AVH021	Channel Registration
AVH022	Striping Evaluation

CCR 1919

3.2.2.2 Changes from NOAA-L—OV Test AVH019 compares AVHRR/3 data sets from two operational spacecraft (NOAA-15 and –16) with NOAA-M values. The NOAA-L OV test compared AVHRR/2 (NOAA-14) and AVHRR/3 (NOAA-15) data sets with NOAA-L values.

3.2.2.3 Trending Data—The following parameters should be monitored for long-term changes and trends:

- Hot Counts/Blackbody Temp vs. Time
- Cold Counts Standard Deviation vs. Time
- Calibration Coefficients vs. Time
- Line-to-Line Jitter vs. Time

3.2.3 HIRS

The HIRS/3 is a 20-channel IR sounder and visible cloud detector which step scans ± 49.5 degrees across nadir with an IFOV of 1.4 degrees circular. Its 20-km diameter footprint is stepped 56 times for approximately 2200-km earth coverage per scan. The scientific purpose is to examine temperature profiles, ozone (total column), cloud top height, surface albedo, water vapor profile, and sea and land surface temperature. As the HIRS/3 completes a scan in 6.4 seconds and provides 13-bit digitization, radiometric samples are produced at a rate of 2.88 kbps.

The IR channels in the HIRS/3 are calibrated absolutely with blackbody radiance standards traceable to NIST. The visible channel is radiance calibrated with an integrating sphere using Halogen lamps that is also NIST traceable. On-orbit calibration linearity and stability for the IR channels are determined by cold blackbody (space) and warm built-in blackbody (approximately 300K) measurements. Visible channel 20 is only zero radiance checked via cold space look, as there is no radiance standard available for this channel.

3.2.3.1 On-orbit Tests—Table 3-4 shows the HIRS on-orbit evaluations that will be performed.

Table 3-4. HIRS Performance Tests

OV Test Number	Name
HIR001	Monitor Analog Telemetry
HIR002	Cooler Outgassing
HIR003	Cooler Heater Off/Cooler Door Deploy/Detectors Cool Down
HIR004	IR Detectors Cool Down Rate and Operational Configuration
HIR005	Operational Evaluation - Normal Scanning
HIR006	NEdα Channel 20
HIR007	Signal Amplitude - Visible Channel 20
HIR008	Filter Wheel Synchronization Evaluation
HIR009	Electronic Calibration Sequence
HIR010	Dark Current Radiometric Level
HIR011	NEdN - IR Channels
HIR012	Instrument Stability Measurement
HIR013	Instrument Trending
HIR014	HIRS Detection of Land-Sea Boundary
HIR015	Satellite-To-Satellite Comparison
HIR016	A/D Converter Evaluation
HIR017	Scanner Evaluation
HIR018	Channel Registration

CCR 1919

3.2.3.2 Changes from NOAA-L—OV Test HIR015 compares HIRS/3 data sets from two operational spacecraft (NOAA-15 and –16) with NOAA-M values. The NOAA-L OV Test compared HIRS/2 (NOAA-14) and HIRS/3 (NOAA-15) data sets with NOAA-L values.

3.2.3.3 Trending Data—The following parameters should be monitored for long-term changes and trends:

- Hot Counts/Blackbody Temp vs. Time

- Cold Counts Standard Deviation vs. Time
- Calibration Coefficients vs. Time

3.2.4 SBUV

The SBUV/2 is an operational spectrally scanning, nadir pointing remote sensor. The instrument is designed to map, on a global scale, total concentrations and vertical distribution of stratospheric ozone. This requirement is met by measuring the solar ultraviolet radiation backscattered from the earth and direct solar irradiance in the 160 to 400 nm range.

The SBUV/2 measures the backscattered radiation in an 11.3° x 11.3° field of view in the nadir direction at 12 discrete, 1.1 nm wide wavelength bands between 252.0 and 339.8 nm using a scanning double monochromator. The solar irradiance is measured at the same 12 wavelength bands by deploying a diffuser that reflects sunlight into the instrument field of view. The SBUV/2 also has the capability to measure the solar irradiance or atmosphere radiance with a continuous spectral scan from 160 to 400 nm in 0.148-nm increments, providing data on the photochemical processes in the atmosphere. A separate narrowband filter photometer, the Cloud Cover Radiometer (CCR), continuously measures the earth's surface brightness outside the ozone absorption band at 379 nm. The CCR's 11.3° x 11.3° field of view is co-aligned with the monochromator's field of view.

The SBUV/2 is a non-spatial, spectrally scanning instrument that operates in four monochromator modes, four scene modes, and a diffuser decontamination mode. The four monochromator modes are the discrete mode, the sweep mode, the wavelength calibration mode, and the position mode. The four scene modes, which are achieved by commanding the diffuser and the calibration lamp, are the earth view, sun view, wavelength calibration, and the diffuser check modes. The SBUV/2 produces radiometric data at an average rate of 0.32 kbps.

3.2.4.1 On-orbit Tests—Table 3-5 shows the SBUV on-orbit evaluations that will be performed.

Table 3-5. SBUV Performance Tests

OV Test Number	Name
SBU001	Power Off/Monitor Telemetry
SBU002	Power On/Monitor Telemetry
SBU003	HV Activation
SBU004	Radiometric Dark Current Level
SBU005	Electronic Calibration
SBU006	Wavelength Calibration Check
SBU007	2-Step Wavelength Calibration Check
SBU008	Lamp Assembly Door Open
SBU009	CCR Functional Test
SBU010	Diffuser Deployment and Outgassing
SBU011	Diffuser Reflectance Measurements
SBU012	Diffuser Repeatability

SBU013	Instrument Trending
SBU014	Goniometric Calibration
SBU015	Diffuser Degradation Check

All the on-orbit tests performed for NOAA-L will be performed again for NOAA-M, without significant changes.

3.2.4.2 Trending Data—The following parameters should be monitored for long-term changes and trends:

- Electronics Calibration vs. Time (Discrete)
- Radiometric Dark Current Level vs. Time (Discrete)
- Diffuser Reflectance vs. Time (Discrete)

3.2.5 Space Environment Monitor (SEM)

The SEM is a multi-channel charged-particle spectrometer that senses the flux of charged particles at the satellite altitude, and thus contributes to the solar-terrestrial energy knowledge. Within the past two decades, great strides have been made in defining the sun's ionized plasma in which the earth is immersed. This solar wind is important because:

- Its pressure configures or contains the earth's magnetic field (the magnetosphere).
- It is a source of particles for the earth's trapped radiation belts.
- It is the primary source of particles for particle precipitation phenomena (aurora).
- It is a major source of the energy input to the earth's atmosphere and ionosphere.

For these reasons alone, a charged-particle sensor to quantify these particle populations and dynamics is an important part of the mission. In addition, however, rather abrupt and large disruptive changes occur to the solar emissions which both dramatically change the instantaneous solar wind properties and also result in the arrival of an intense flux of high-energy (1 to over 1000 MeV) solar protons and alpha particles. Such events can result in dramatic changes to the magnetosphere geometry, large changes in energy inputs to the ionosphere and atmosphere disturbance or blackout of communications, excessive magnetic coupling to levels sufficient for burnout or circuit breaker trip of power and land-line communications systems, and even a radiation dosage threat to manned high-altitude flight.

The SEM contains two separate sensors with a common Data Processor Unit (DPU). The Total Energy Detector (TED) uses a programmed swept electrostatic curved-plate analyzer to select particle type/energy and a channeltron detector to sense/quantify the intensity of the sequentially selected energy bands. The particles of interest range from 50 eV to 20 KeV. The Medium Energy Proton Electron Detector (MEPED) senses protons, electrons, and ions with energies from 30 KeV to several tens of MeV. The MEPED utilizes solid-state nuclear detectors and appropriate arrangements of moderating materials to establish the energy band resolution.

3.2.5.1 On-orbit Tests—Table 3-6 shows the SEM on-orbit evaluations that will be performed. OV Test SEM005 is a *contingency* test due to the NOAA-L testing experience.

Table 3-6. SEM Performance Tests

OV Test Number	Name
SEM001	SEM Temperature Verification
SEM002	DPU and TED Low Voltage Activation
SEM003	MEPED and IFC Activation
SEM004	TED HV and IFC Activation
SEM005	TED HV Step-*Contingency*
SEM006	SEM Trended Data

3.2.5.2 Trending Data—The following parameters should be monitored for long-term changes and trends:

- SEM Electronic Calibration vs. Time (Discrete)
- A/D Converter Calibration vs. Time (Discrete)
- Background Counts vs. Time
- DPU, TED and MEPED Selected Parameters

3.3 DCS

DCS assists NOAA in its overall environmental mission. Platforms (buoys, free-floating balloons, and remote weather stations) collect relevant data and transmit them to the satellite. The onboard DCS receives the incoming signal, measures both the frequency and relative time of occurrence of each transmission, and the spacecraft retransmits these data via the CDA stations through SOCC to the central processing facility. The DCS information is decommutated and sent to the French Data Collection System (ARGOS) processing center where it is processed, distributed, and stored on magnetic tape for archival purposes.

The DCS checkout is performed by Centre National d' Etudes Spatiales (CNES), the French space agency in Toulouse, France. In order to send messages to the instrument for tests, spacecraft scheduling data is provided to CNES for orbits over Lannion, France, a CDA station. Lannion is close enough to Toulouse so that uplinked test messages can be received by the DCS. All problems, anomalies, and test results are reported to the POES DCS Lead, who serves as the interface between NASA and CNES.

The DCS is capable of receiving eight simultaneous transmissions that are processed in individual detectors termed Data Recovery Units (DRUs). The first portion of the test checks each DRU separately. For this portion each DRU is commanded on in sequence starting with unit number 8 and ending with unit 1. The last part of the test checks the DCS's ability to process 8 messages simultaneously. Each test process consists of measuring the accuracy of location, digital accuracy of transmitted message and time code accuracy. Test data is stripped out of TIP telemetry and sent to CNES by SOCC.

All the on-orbit tests performed for NOAA-L will be performed again for NOAA-M, without significant changes.

3.4 SAR COMPLEMENT

The SAR instruments consist of a 3-band (121.5, 243, and 406.05 MHz) SARR and a 406.025-MHz SARP with memory. The SARR downlink is at 1544.5 MHz and, besides the three repeated bands, also includes the 2,400 bps bit stream SARP output. The 121.5 and 406 MHz bands are also serviced by Russian COSPAS satellites that, together with the NOAA satellites, provide improved timeliness of response.

The 121.5 and 243 MHz bands service emergency beacons that are required on many aircraft, with a smaller number carried on maritime vessels. The 406 MHz band presently services the U.S. commercial fishing fleet and large international ships, which are required to carry emergency beacons. International aviation will be required to carry 406 MHz band emergency beacons by 2005.

3.4.1 SARR

The SARR checkout is performed at the System Evaluation and Development Laboratory (SEDL) at GSFC and the Canadian Telemetry Evaluation Center (CTEC) in Canada. Historically the tests are performed cooperatively with the assignments of particular orbits done on an ad hoc basis taking into account elevation angles and terrestrial activities. Testing is performed in both the normal Automatic Gain Control (AGC) mode and the fixed gain mode. The CTEC concentrates its efforts on the characteristics of the repeater, while the GSFC SEDL concentrates on the antenna characteristics. Both facilities have calibrated uplink capabilities.

During antenna testing, which requires the channel under test to be in the fixed gain mode, tests that can be performed with low-level signals can be performed on the remaining channels that are in the AGC mode. While it is technically feasible to simultaneously perform multiple tests on the separate channels, this has proven impractical due to equipment and manpower limitations.

The following on-orbit evaluations will be performed:

- Downlink carrier stability
- Channel frequency response
- Modulation indices
- Spurious emissions
- Modulation linearity
- Antenna patterns
- Interchannel crosstalk

- Signal translation accuracy

All the on-orbit tests performed for NOAA-L will be performed again for NOAA-M, without significant changes.

3.4.2 SARP

Following the launch of each new satellite, initial on-orbit tests are conducted to confirm that the SARP payload meets the interoperability requirements and is functioning within the required range.

The initial on-orbit tests provide a set of baseline values for various parameters at the time the satellite begins operations. The baseline values can be compared with pre-launch data to determine if on-orbit operation is nominal and with results from subsequent on-orbit tests to monitor ongoing performance trends.

The following on-orbit tests are used to evaluate and characterize the performance of the SARP:

- SARP 406 MHz Receive Antenna Pattern
- SARP Calibration on SARSAT
- SARP Performance with Test Signals

Additional tests of SARP are performed by CNES in Toulouse, France. These test transmissions are made from Toulouse, France, when the spacecraft is over Lannion, France. The three DRUs on SARP are tested individually by turning them on in sequence starting with unit three. The last test consists of simultaneous transmissions of three messages. Each test process consists of measuring the accuracy of location, digital accuracy of the transmitted message, and time code accuracy. Test data is taken from the SARR L-band downlink. All problems, anomalies, and test results are reported to the POES SARP Lead.

All the on-orbit tests performed for NOAA-L will be performed again for NOAA-M, without significant changes.

4. SCIENCE DATA

The tests described in Section 3 will evaluate the engineering performance of the instruments. Each instrument's science data will then be examined to the radiance level. CEMSCS, the NOAA polar product software, will be utilized in this assessment.

NASA is not involved in the creation of operational polar data products (1B data sets); that is performed by NOAA and the end-users in the science community. The development and fine tuning of the algorithms to transform 1B data sets into polar output products, such as sea surface temperatures or water vapor profiles, is not part of the NOAA-M OV effort. However, NASA will coordinate the NOAA-M checkout activities with the NOAA scientists and product developers.

5. OV TEST CONDUCT

This section describes the support required to conduct the OV for NOAA-M.

5.1 ORGANIZATIONAL ROLES AND RESPONSIBILITIES

The OV team is an integral part of the overall NOAA-M Flight Operations Team (FOT). During the OV period, the FOT ensures the health and safety of the NOAA-M spacecraft, while the OV team conducts the prescribed tests. The OV team works closely with the FOT and is required to coordinate all OV activities with the FOT. To maximize the resource utilization, the same engineer can function on both teams as needed.

The NOAA-M OV team consists of representatives from the following organizations:

- NASA
- NASA POES systems engineering contractors
- LMSSC, the spacecraft vendor
- Instrument vendors.

Members from NOAA at the NASA Liaison Office, NOAA SOCC and Engineering Mission Operations Support Services (EMOSS) contractors are encouraged to take an active part in the OV activities.

5.1.1 OV Management

Overall management of the OV activity is provided by the Flight Operations Manager, David Littmann. Fundamental responsibilities include:

- Ensure the development of overall OV test, analysis, and support plans from subsystem and instrument inputs.
- Define the staffing plan to conduct the OV tests.
- Coordinate and commit NASA resources in support of the OV tests.
- Maintain the OV test activities schedule.
- Attend the Daily Status Meeting.
- Ensure the review of spacecraft and instrument performance evaluation resulting from OV testing.
- Review and maintain NOAA-M OV Problem Reports.
- Oversee development of the OV test results presentation to NOAA, from subsystem and instrument inputs.
- Oversee development of the post-test OV report, from subsystem and instrument inputs.

5.1.2 Spacecraft OV Team

Table 5-1 presents the Spacecraft OV team organization and its members. Subsystem OV team members are NASA POES systems engineers and engineering contractors.

Table 5-1. NOAA-M Spacecraft OV Team

Position	Lead
Spacecraft Team Leader	S. Pszcolka
Test Coordinator	R. Bowling
Subsystem	**Lead**
System	D. Coolidge
ADACS	J. Blue
Communications	P. Acosta
C&CS and DHS	Y. Tiwary
Power	T. Spitzer
RCE	R. Estes
Thermal	J. Hunter
Deployment	J. Stivaletti
Flight Software	E. Jay

5.1.3 Instrument OV Team

Table 5-2 presents the Instrument OV team organization and its members. Instrument OV team members are NASA POES systems engineers and engineering contractors.

Table 5-2. NOAA-M Instrument OV Team

Position	Lead	
Instrument Team Leader	M. Walker	
Test Coordinator	R. Bowling	
Instrument	**Lead**	**Vendor**
AMSU-A1 and -A2	M. Liptak	Northrop Grumman Electronic Systems
AMSU-B	H. Goldberg	UK Met
AVHRR and HIRS	C. Richardson	ITT
SEM	J. Cardone	Panametrics
SBUV	J. Mentall	Ball Aerospace
DCS and SARP	J. Mentall	CNES
SARR	J. Mentall	Canadian Department of National Defense

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5.1.4 Spacecraft and Instrument OV Team Leaders

The Spacecraft and Instrument OV Team Leaders have the overall responsibility to conduct the OV tests during the OV period. They are the prime interface with the MOM for the planned activities and any changes or deviations to the schedule. Anomalies observed during the test and post-test activities will be brought to the attention of the MOM. Responsibilities of the Team Leaders include:

- Conduct the spacecraft and instrument OV tests.
- Interface with the spacecraft and instrument vendors.
- Commit NASA resources to ensure the OV test schedule integrity.
- Resolve schedule conflict among the subsystem and instrument teams.
- Act as prime interface with the MOM for any changes to the test schedule.
- Attend the Daily Briefing Meeting.
- Report any anomalies or deviations observed during the test to the MOM and NASA OV Manager, and ensure that they are documented.
- Support anomaly investigation according to the TIROS Orbital Anomaly Report (TOAR) process.

5.1.5 Subsystem Leads

NASA GSFC subsystem engineers will be the OV test subsystem team leads during the OV tests for their subsystems. They will determine their team makeup to execute these tests and can request additional support through the NASA Spacecraft OV Team Leader during either the real-time data capture/analysis of a specific test or during the post-test analysis of the data. Their responsibilities include:

- Provide inputs for the development and definition of the OV tests.
- Conduct the OV tests and provide technical support required for executing the specific subsystem testing.
- Support anomaly investigation and ensure that all anomalies are documented according to the established TOAR process.
- Coordinate the execution of subsystem testing or schedule changes with the NASA Spacecraft OV Team Leader.
- Act as prime interface with the LMSSC and the NOAA engineers.
- Recommend additional testing, if appropriate.
- Analyze the OV test results and determine the spacecraft status.
- Attend the Daily Briefing Meeting, Daily Planning Meeting, NOAA-M Pre-Pass Meeting, and NOAA-M Post-Pass Meeting during the scheduled tests.
- Provide spacecraft subsystem and test status to the MOM during the testing and to the NASA OV Manager in the OV Daily Briefing Meeting.
- Present the subsystem OV test status and report to NOAA.
- Conduct the post-test data analysis and write the OV Test Report for the respective subsystem.

5.1.6 Instrument Leads

NASA GSFC instrument leads will be the OV test instrument team leads during the OV tests for their instruments. They will determine their team makeup to execute these tests and can request additional support through the NASA Instrument OV Team Leader during either the real-time data capture/analysis of a specific test or during the post-test analysis of the data. Their responsibilities include:

- Provide inputs for the development and definition of the OV tests.
- Lead the responsible area of the Instrument OV team. The Instrument OV team encompasses members from the instrument vendors and the NASA POES engineering contractors.
- Function as the primary interface to the instrument vendors and the NOAA engineers.
- Coordinate the execution of instrument activation or schedule changes with the Instrument OV Team Leader.
- Conduct the OV tests and provide technical support required for executing the specific instrument testing.
- Support anomaly investigation and ensure that all anomalies are documented according to the established TOAR process.
- Analyze the OV test results and determine the instrument status and its performance.
- Recommend additional testing, if appropriate.
- Attend the Daily Briefing Meeting, Daily Planning Meeting, NOAA-M Pre-Pass Meeting, and NOAA-M Post-Pass Meeting during the scheduled test.
- Provide instrument test status to the MOM during the testing and to the NASA OV Manager in the OV Daily Briefing Meeting.
- Present the instrument OV test status and report to NOAA.
- Conduct post-test data analysis and write the OV Test Report for the instrument.

5.1.7 OV Team Members

Representatives from NASA GSFC Code 480 and its contractors form the teams to conduct the NOAA-M OV tests. Members from NOAA and its contractors are encouraged to actively participate in these test activities. Responsibilities include:

- Develop the OV test command procedures and appropriate PACS display pages and plots to conduct the OV tests specified in the *NOAA-M On-orbit Verification Test Description and Analysis Plan.*
- Assist the Subsystem/Instrument Lead in executing the OV tests as planned in the FTT. This includes monitoring the telemetry identified in the OV tests, collecting the PACS display pages, monitoring the results of the OV test after an OV command procedure is issued, and collecting the plots and PACS files after the test.
- Assist the Subsystem/Instrument Lead in determining the status and performance of spacecraft subsystem or instrument.
- Assist in anomaly investigation and ensure that all anomalies are documented according to the established TOAR process.
- Attend the Daily Briefing Meeting, Daily Planning Meeting, NOAA-M Pre-Pass Meeting, and NOAA-M Post-Pass Meeting during the scheduled test.

- Assist the Subsystem/Instrument Lead in the post-test data analysis and the development of the OV Test Report for the responsible area.

5.1.8 OV Test Coordinator

The OV Test Coordinator will coordinate test activities between the FOT and the OV Team. The OV Test Coordinator will track the progress of each OV test and provide liaison support to all affected members of the OV team in the event of schedule changes. The Test Coordinator will ensure that all tests are scheduled prior to their being executed. Responsibilities are listed below:

- Coordinates the OV testing.
- Acts as prime interface with the Spacecraft and Instrument OV Team Leaders to resolve conflicts in OV test schedule, as required.
- Keeps track of the status of the overall test program.
- Provides routine test status (daily, weekly, etc.) to management as required.
- Conducts a daily briefing to review status of testing and to coordinate upcoming test schedule with the MOM.

5.1.9 Instrument Vendors

The instrument vendor representatives are required to be on-site at NOAA SOCC during the instrument activation period and on-call to support test evaluation. Their responsibilities include:

- Support the on-site activities during activation of their instrument.
- Provide preliminary assessment of instrument status and performance.
- Support test data collection.
- Recommend additional testing, if appropriate.
- Assist in anomaly investigation according to the established TOAR process.
- Attend the Daily Status Meeting, Daily Planning Meeting, NOAA-M Pre-Pass Meeting, and NOAA-M Post-Pass Meeting during the instrument activation period.
- Remain on call to support test evaluation for the duration of the OV period.

5.1.10 NOAA-M MOM

The MOM is responsible for overall NOAA-M operations from pre-launch through the end of OV. The responsibilities pertaining to the OV activities are listed below:

- Provides authorization for all nominal test procedures.
- Provides authorization for execution of contingency procedures and recovery actions.
- Coordinates NASA resources in support of the NOAA-M mission.
- Acts as prime interface with the Spacecraft and Instrument OV Team Leaders in execution of the OV tests as scheduled in the FTT.
- Acts as prime interface with the Spacecraft and Instrument OV Team Leaders in coordinating any changes or deviations to the OV tests as planned in the FTT.
- Acts as prime interface for anomaly investigations.

- Conducts the Daily Status Meeting, Daily Planning Meeting, NOAA-M Pre-Pass Meeting, and NOAA-M Post-Pass Meeting.

5.1.11 SOCC Data Technician

The SOCC Data Technician provides support to the OV teams in the following areas:

- Has responsibility for generating off-line data plots and data files as requested by a specific Request Form. Samples of the Request Forms are included in Appendix C.
- Provides assistance to OV teams (where possible) when addressing the operations of the PACS workstations.

5.1.12 NOAA-M OV Support Functions

The following organizations provide general support to the OV teams.

5.1.12.1 SOCC Operations Branch-The SOCC Operations Branch personnel will be responsible for the configuration of the ground system, including data lines and PACS equipment. The SOCC Operations Branch is also responsible for sending the commands to the NOAA-M spacecraft for the OV test execution.

5.1.12.2 SOCC Software Branch-The NOAA SOCC Software Branch will provide support as needed during the OV testing. A representative of the SOCC Software Branch will be responsible for system maintenance and trouble-shooting in the event of software problems at the SOCC and will be available by pager.

5.1.12.3 SOCC Support Branch-The NOAA SOCC Support Branch including the Electronics Maintenance Section (EMS) will provide support on an as-required basis during the OV testing. A representative of the EMS will be responsible for system maintenance and trouble-shooting in the event of hardware problems at the SOCC. The EMS representative will be listed as key personnel for the test and will be available by pager.

5.2 STAFFING PLAN

The NOAA-M OV requires the OV team members to be present during their specific real-time pass(es) for the execution of their tests. The tests, for the most part, are scheduled during days and swing shifts. The OV team is described in Section 5.1. The subsystem/instrument leads are responsible for determining the members of the test team for each OV test. They may request additional support for particular tests or for specific data analysis efforts after the real-time portion of the test is completed. Each team member's role and responsibility is delineated in Sections 5.1.4 through 5.1.12. The specific work schedule of each OV team member depends upon the scheduled OV tests.

From launch and throughout the activation phase, the FOT staff will be present around the clock, seven days per week, and will deal primarily with the health and safety of the spacecraft.

5.3 TEST RESOURCE REQUIREMENTS

The resources required for the OV are described in detail in the individual OV test descriptions and analysis plans.

5.3.1 Ground System Requirements

The ground system requirements needed for the OV are described in the individual OV test descriptions and analysis plans. These requirements include ground system support from the SOCC at Suitland, Maryland, as well as the CDAs at Wallops Island, Virginia, and Fairbanks, Alaska.

5.3.2 Facility Requirements

The facilities required to perform the OV for the most part are described in the *NOAA-M Launch Management Plan*, as well as in each of the OV test descriptions and analysis plans. These facilities include the equipment at SOCC and the equipment required to produce the science 1B data products at the NOAA CEMSCS.

5.4 TEST EXECUTION

Each on-line OV test that requires commanding the spacecraft is scheduled in the FTT. The OV tests are categorized into three areas: a.) on-line with commanding, b.) on-line without commanding and c.) off-line tests. Each test identifies what commands to send, what data to retrieve, and/or what plots or reports to generate.

5.4.1 FTT

The FTT has each OV test scheduled as well as the products requested to be generated by the data technician. If a test is scheduled more than once, there will be a separate entry in the FTT for each execution of that test. Any changes (including additional OV tests) need to be documented and approved before they can be added to the FTT and executed. The *NOAA-M OV Test Description and Analysis Plan* describes the process for making changes to an existing OV test or adding a new test.

5.4.2 Test Schedule Changes

Appendix C contains the form used to modify the schedule and or add OV tests to the schedule. All parties required to approve the changes must have signed the form before the change can be scheduled. During the actual OV period the required personnel to sign off of OV changes should be at the SOCC, and the process of modifying existing tests should not be a time consuming event. The OV Test Coordinator is responsible for informing all concerned parties that a change has been made to the schedule and ensure that any conflicts have been resolved.

5.4.3 Test Monitoring

An OV Test team member will be present at the SOCC during the real-time pass for each OV test identified as "on-line with commanding." The OV tests that are "on-line without commanding" can be monitored at the SOCC or at the remote PACS workstation at GSFC in Building 6. For tests identified as "off-line," a representative of the OV test team does not need to be present during the real-time pass.

5.4.4 Product Generation

For the spacecraft subsystems, the OV team will request the majority of the products to be generated by the SOCC Data Technician, either through the FTT or via the specific request forms. Appendix C gives the forms required to be completed when a specific plot or report is requested during the OV period. For specific instruments, the OV team will need CEMSCS support in generating various scientific products. The special products and/or unique software that are required for creating OV products are delineated in the specific OV analysis plans. The OV team will ask the CEMSCS to generate both standard 1B data sets and a limited number of unique products during the OV.

5.4.5 Problem Reporting

Problem reporting will be performed as documented in *NOAA/NESDIS Ground System Configuration Management Plan for Satellite Operations*. POES Incident Reports (PIRs) will be generated and submitted to the Polar Action Review Board (PARB) for ground system or database problems. Meetings will be held periodically by the NASA OV Manager to determine the status of each of the PIRs. Spacecraft or instrument problems will be handled through the TOAR process.

5.4.6 Daily Status Meeting

During the OV period a Daily Status Meeting will be held to provide overall status of the NOAA-M spacecraft, highlight significant events or action plans, and to recap the previous day's OV activities. This meeting will also be accessible through teleconferencing at NASA GSFC and LMSSC. The MOM will chair the Daily Status Meeting. The NASA OV Manager will provide a recap of the OV activities and will preview the OV test objectives for the next 24 hours.

5.5 OV FINAL PRESENTATION AND TEST REPORT

A presentation will be made to NOAA summarizing the results after all OV tests are complete. In addition, a final OV Test Report will be written by NASA personnel and delivered to NOAA. The OV Test Report will summarize results by subsystem and instrument, and will also contain the results of every OV test. Table 1-4 shows the timeline.

For the SAR complement, test results of the DCS and SARP payloads will be provided to NASA by CNES, the French control center responsible for these payloads. SARR test results will be provided by CTEC, the Canadian control center. These results are expected in a timely manner, so that they can be inserted into the OV Test Report. In addition, the GSFC SEDL will generate a SARSAT test report that contains the results of testing SARR antennas.

There will be a single complete OV Test Report for NOAA-M.

6. LIST OF REFERENCES

	Memorandum of Understanding - NOAA-K, L, M, N, N' Joint Launch and Mission Operations, May 2001
	NOAA/NESDIS Ground System Configuration Management Plan for Satellite Operations, Revision 1, February 1998
S-480-162	*NOAA-M Launch Management Plan*, January 2002
S-480-150	*NOAA-M On-orbit Verification Test Description and Analysis Plan*, April 2002

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7. LIST OF ACRONYMS

A/D	Analog to Digital
ADACS	Attitude Determination and Control Subsystem
AFSCN	Air Force Satellite Control Network
AGC	Automatic Gain Control
AGS	Ascent Guidance Software
AKM	Apogee Kick Motor
AIP	Advanced Microwave Sounding Unit Information Processor
AMSU	Advanced Microwave Sounding Unit
APT	Automatic Picture Transmission
ARGOS	French Data Collection System
ATN	Advanced TIROS-N
AVHRR	Advanced Very High Resolution Radiometer
BCA	Battery Charge Assembly
BER	Bit Error Rate
BTX	VHF Beacon Transmitter
BVR	Boost Voltage Regulator
C&CS	Command and Control Subsystem
CCR	Cloud Cover Radiometer
CDA	Command and Data Acquisition
CEMSCS	Central Environmental Satellite Computer System
CIU	Control Interface Unit
CNES	Centre National d' Etudes Spatiales
COP	Contingency Operations Procedure
COSPAS	Search and Rescue Program of Russia
CPC	Controls Power Converter
CPU	Central Processing Unit
CRT	Cathode-Ray Tube
CS	Communications Subsystem
CTEC	Canadian Telemetry Evaluation Center
CXU	Control Interface Unit Annex
DAU	Decryption Authentication Unit
DCS	Data Collection System
DDR	Digital Data Recorder
DHS	Data Handling Subsystem
DRU	Data Recovery Unit
DSN	Deep Space Network
DTR	Digital Tape Recorders

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EED	Electroexplosive Device
EIRP	Effective Isotropic Radiated Power
EMI	Electromagnetic Interference
EMOSS	Engineering Mission Operations Support Services
EPS	Electrical Power Subsystem
ESA	Earth Sensor Assembly
EU	Electronic Units
FFT	Fast Fourier Transform
FOT	Flight Operations Team
FTT	Flight Time Table
GAC	Global Area Coverage
GRD	Ground Spaceflight Tracking and Data Network Receiver Demodulator
GSFC	Goddard Space Flight Center
GSTDN	Ground Spaceflight Tracking and Data Network
HIRS	High Resolution Infrared Radiation Sounder
HRPT	High Resolution Picture Transmission
IFOV	Instantaneous Field of View
IMP	Instrument Mounting Platform
IMU	Inertial Measurement Unit
IR	Infrared
LAC	Local Area Coverage
LMSSC	Lockheed-Martin Space Systems Company
LO	Local Oscillator
MEPED	Medium Energy Proton Electron Detector
MIRP	Manipulated Information Rate Processor
MOM	Mission Operations Manager
NASA	National Aeronautics and Space Administration
NEdα	Noise Equivalent Change in Albedo
NEdN	Noise Equivalent Spectral Radiance
NEdT	Noise Equivalent Spectral Temperature
NESDIS	National Environmental Satellite, Data and Information Services
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
OV	On-orbit Verification

PACS	Polar Acquisition and Control System
PARB	Polar Action Review Board
PIR	POES Incident Report
PLL	Phase Lock Loop
PMS	Power Management Software
POES	Polar Operational Environmental Satellites
PSE	Power Supply Electronics
RCE	Reaction Control Equipment
RF	Radio Frequency
RSS	Reaction Control Equipment Support Structure
RWA	Reaction Wheel Assembly
RXO	Redundant Crystal Oscillator
S/C	Spacecraft
S/N	Signal to Noise
SA	Solar Array
SAD	Solar Array Drive
SAR	Search and Rescue
SARP	Search and Rescue Processor with Memory
SARR	Search and Rescue Repeater
SARSAT	Search and Rescue Satellite Aided Tracking
SBUV	Solar Backscatter Ultraviolet Spectral Radiometer
SCP	Standard Controls Processor
SCU	Signal Conditioning Unit
SEDL	System Evaluation and Development Laboratory
SEM	Space Environment Monitor
SEPET	System Electrical Performance Evaluation Test
SLA	Search and Rescue Repeater L-band Transmitter Antenna
SOA	S-band Omni-telemetry Antenna
SOCC	Satellite Operations Control Center
SRA	SARR Receiver Antenna
STX	S-band Transmitter
TCS	Thermal Control Subsystem
TED	Total Energy Detector
TIP	TIROS Information Processor
TIROS	Television Infrared Observation Satellite
TOAR	TIROS Orbital Anomaly Report
UDA	UHF DCS/SARP Receiver Antenna
VRA	VHF Real-time Antenna

VTX	VHF Real-time APT Transmitter
XSU	Cross Strap Unit

APPENDIX A -- OV TEST NUMBERING SYSTEM

Each test has a unique number that begins with three alpha characters and is followed by three numbers (beginning with 001 for each subsystem or instrument). The following list appears in the order presented in this document.

SYS001	=	System
ADC001	=	ADACS
COM001	=	COMM
CCS001	=	Command and Control
DHS001	=	DHS
EPS001	=	EPS
RCE001	=	Reaction Control
THR001	=	Thermal
DEP001	=	Deployment
AM1001	=	AMSU-A1
AM2001	=	AMSU-A2
AMB001	=	AMSU-B
AVH001	=	AVHRR
HIR001	=	HIRS
SBU001	=	SBUV
SEM001	=	SEM
DCS001	=	DCS
SAR001	=	SARR
SAP001	=	SARP

APPENDIX B -- NOAA-M OV TEST FORMAT DESCRIPTION

Item	Description
Test Number	Unique identifier beginning with 3 alpha characters to describe the subsystem or instrument followed by 3 numbers (beginning with 001) for the first test of that subsystem or instrument, i.e., ADC001 for the first test of the ADACS
Test Name	Unique name given to this specific test
Test Duration	Number of orbits before turn on, estimate of time required to execute the test including minimum number of orbits between each activity and collection of the data
Specification	What specification or requirement is this test verifying (identify the specification not just the specification number)
Objective	State the objectives of this test
Description	Describe the test; include specific configuration operations should know or execute the test in
Risk Assessment	Describe the specific risk to the spacecraft in performing this test
Prerequisites and/or Constraints	Identify any requirements to be met before initiating the test and any operational constraints to be honored during testing
Recommendations and/or Comments	Provide operations with any pertinent comments or recommendations to perform this test, i.e., stand alone test or run in parallel with another
Success Criteria	Identify the success criteria using CRT monitor page; identify plot requirements and outside support required
Responsible Party	Signature of the individual representing the responsible organization for the analysis of the test and the generation of the final test report.
Command Requirements	Identify if any commanding is required during the station pass to perform the test
Last Update	The date of the last update of this test description

APPENDIX C -- FORMS

Appendix C contains the forms to add or modify OV tests. These forms must be completed and signed by all parties prior to modifying OV tests or the OV test schedule. The forms are:

- FTT CHANGE REQUEST Figure C-1
- NOAA-M PLOT REQUEST FORM Figure C-2
- NOAA-M REPORT REQUEST FORM Figure C-3

Flight Time Table Change Request

By Who:____________________________ Present Date:_______________________________
(Name)

Section(s) to modify:________________
(A, B, C, D)*

Add, Mod or Delete:________________ Rev. Number_________Station________________

Reason for Change:____

____

____

Change:____

____

____

____

____

____

____

* A = Pass Activities
B = Pass Activities Notes
C = CEMS requirements
D = Post Pass Activities

Submit Request to OV Test Coordinator

Figure C-1. FTT Change Request

NOAA-M Plot Request Form

Name: ____ Time:_______________
____

Plot type: Check One [ ] History Plot , or [ ] Trends Plot

Start Time: ____________________________________ Stop Time:
____

For pre-existing plot setup files, enter the following:

Single Plot Setup Name: ______________________________

Or, Multiple Plot Procedure Name:
____

For non-existing plot setups, complete the remaining data:

Plot Setup Name: ____________________ (Up to 8 Characters)

Sampling Period: ________________ (hh:mm:ss format,8 sec.default)

Title:
____

Description:
____

```
+------------------------------------------------------------
--+
|      Y-Axis           | Graph  |        |  Plot   | Low Y |
HighY |
|     Mnemonic           | Number | Y-Type | Option | Scale |
Scale |
|                       | 1 to 4 | 1 to 4 |   1/2   |       |
|
|-------------------+--------+--------+--------+-------+-----
--|
|1.                     |        |        |        |       |
|
|-------------------+--------+--------+--------+-------+-----
--|
|2.                     |        |        |        |       |
|
|-------------------+--------+--------+--------+-------+-----
--|
```

```
|3.                    |         |         |         |        |
|
|--------------------+--------+--------+--------+-------+-----
--|
|4.                    |         |         |         |        |
|
|--------------------+--------+--------+--------+-------+-----
--|
|5.                    |         |         |         |        |
|
|--------------------+--------+--------+--------+-------+-----
--|
|6.                    |         |         |         |        |
|
|--------------------+--------+--------+--------+-------+-----
--|
|7.                    |         |         |         |        |
|
|--------------------+--------+--------+--------+-------+-----
--|
|8.                    |         |         |         |        |
|
+-------------------------------------------------------------
--+
Notes:
Y-Type  for    History Plots:                      Trends Plots:
           1 - Raw (Counts)                     1 - Mean
           2 - Engineering Units (EU)           2 - Min
                                                3 - Max
                                                4 - Std Dev
Plot Option:
1 - Line Plot                  Low and High Y Scales of 0. will
2 - Scatter Plot               perform autoscaling.
Submit completed form to the EMOSS Test Director (TD)
```

Figure C-2. NOAA-M Plot Request Form

NOAA-M Report Request Form

Name: ______________________________ Date/Time: _____________________

Report type: Check One [ ] History Report, or [ ] Trends Report

Start Time: ____________________Z Stop Time: ____________________Z
(format= YY/DDD/HH:MM:SS.S YY/DDD/HH:MM:SS.S)

****

If you wish to use existing SETUP file(s), provide either the:

Report Setup File Name: ____________________________________ or

Procedure File Name: ____________________________________

****

If you wish to create a new Report SETUP File, provide the following information:

Report Setup Name: ____________________ (up to 8 characters)

Description:
____
____

Sampling Period: ____
(format= DDD/HH:MM:SS.S)

Telemetry Mnemonic	Type (1 or 2)	Format (I,O,Z or 0-9)
1.		
2.		
3.		
4.		

Legend:

Type 1= Raw Data (ie counts)

Type 2= Engineering Units(EU)

```
  5.                                Format I= Integer
  6.                                Format O= Octal
  7.                                Format Z= Hexadecimal
  8.                                Format 0-9= # Decimal
Digits
  9.
 10.


    Submit Completed Form to the EMOSS Test Director (TD)
```

Figure C-3. NOAA-M Report Request Form